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DEGENERATION THE LAW OF DISEASE.

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WHETHER we accept the law of evolution as given to us by its great apostle Herbert Spencer and his followers as true in all its details or not, its general principles we must admit, for they are incontrovertible and have been accepted by the best scientific men of the time, and we must also admit that it is, to say the least, like the law of gravitation, the best working hypothesis extant It embraces all the phenomena of the universe in its threefold character of:

1. Those changes seen in all departments of nature, whether physical, chemical, biological or sociological in which the structure changes from a lower to a higher or more fully developed form, from the simple to the complex, from the homogeneous to the heterogeneous, and definitely described by E. Ray Lancaster as the law of elaboration or the law of progress, or perhaps better illustrated by those changes which take place in the evolution or development of the embryo while passing from its first beginnings through its pre-natal existence and youth to full maturity.

2. Those changes, typical examples of which may be seen everywhere in nature, in which though constantly undergoing change the resulting product seems to maintain the same form, exactly fitted to its conditions and maintained as it were in a state of balance. This is known and described as the law of balance. As examples of this we may mention among living forms the lowest types of animal life at present existing, such as the microscopic animalcules, the amebæ and infusoria, the simpler living mollusca or shellfish, some of the simpler vertebrates and worms.

3. Those changes from a higher to a lower form, from the complex to the simple, from the heterogeneous to the homogeneous, in which the organism becomes adapted to less varied and less complex conditions of life, in which there is suppression of form corresponding to the cessation of work. Dr. Dohrn of Naples has named this the law of degeneration, and it is found to have a wide application in explaining existing forms of life and pathological processes. Elaboration of some one organ may be a necessary accompaniment of degeneration in some or all the others. In fact this is very generally the case, and it is only when the total result of the elaboration of some organs and the degeneration of others is such as to leave the whole animal in a lower condition, that is, fitted to less complex action and reaction in regard to its surroundings than was the ancestral form with which we are comparing it (either actually or in imagination), that we speak of that animal or plant as an example of degeneration.

But we speak of degeneration of parts of an animal or plant in cases even where the organism as a whole may be spoken of as an example of elaboration; and pathology deals with these varying, complicated, fluctuating, morbid processes of rapid or slow development with improvement or relapses so that processes of degeneration and regeneration are mingled with one another instead of developing in a regular series; and manifold lesions affecting only parts of the nerves and muscles in varying combination may occur.

Naturalists have long recognized parasites of all kinds as instances of degeneration, and there are many lizard-like animals

which show a gradual loss of limbs, a local or limited degeneration. The common lizard (*Lacerta*) with its five toes has degenerate relatives in seps and bipes in which the limbs have entirely vanished or preserve only rudimentary forms.

The paleontological history of the horse shows an elaboration of type but a local atrophy or degeneration in the feet from five digits to one digit, its present form. Other illustrations of general and local degeneration will readily occur to the reader, for the whole field of comparative anatomy and embryology is full of them and this law of degeneration clearly explains many vegetable phenomna otherwise inexplicable.

In tracing the growth and decay of languages, nations, societies, philosophies and religions we perceive everywhere the laws of elaboration, balance and degeneration exemplified.

But it is particularly with reference to the law of degeneration and its relation to pathology that I write. Those anatomical or histological changes brought about by any new set of conditions that surround a plant or animal, when of such a character as to transform the organism or any parts of it, to a lower or more degenerate form follow, in many cases, if not in all, in an inverse order the same steps that occurred during the elaboration or embryonic growth of the structure.

So long as this degeneration of organs or tissues is so gradual that the system at large is able to adapt itself to the new conditions, no physiological inharmony results. But when, because of changed and sudden influences, certain organs or tissues degenerate or revert towards their embryonic form more rapidly than the general system can follow, then physiological inharmony results and we have perverted physiological action; in other words, we have disease. Not that degeneration either general or local is disease, but that degeneration is the generic term of which disease is but a part; or, to put it more logically, some degeneration is disease, all disease is degeneration or a reversion of structure towards the embryonic condition.

In this law of degeneration, which is but a part of the great law of evolution, we expect to find the solution of many an intricate problem that now vexes the pathologist and practical physician. The recognition of this law as applying to pathology

is to my mind one of the grandest steps of progress in the art of healing that has been made for many a day.

You may say this is but an hypothesis, and so it is, but it harmonizes more facts than any other and hence becomes a very probable hypothesis, almost ceasing to be hypothetical; and its high probability causes it to be regarded as a law. That it will be verified by the observations and experiments of many workers in the field of pathology I verily believe.

Without attempting a demonstration of this law, nor promising to answer all questions that may arise, I present the subject for careful consideration, and briefly consider a few facts corroborative of its truth.

The mature body is not a numerical accumulation of cells; it is one complex mass of living matter, and one of its phases is its reticular arrangement of protoplasm (or bioplasm) in the meshes of which may be found the non-living matter. We may never be able to solve the mystery that surrounds this living matter, nor even to scan it deeply from a chemical standpoint, but we know some parts of it are much more highly differentiated than others, and we also know that the most highly differentiated is the least stable and hence the most liable to disease.

Degeneration may be seen in non-living matter, but that only which is alive can become the subject of disease. Hence there can be but one pathology and that is the pathology of living matter.

Before divided nerves, muscles, bones, or any of the tissues can begin the process of repair, the edges, ends or parts so severed must undergo the change from living matter of a higher type to living matter of a lower type; in other words, it must first return to the embryonic condition before repair begins. From this point it is a process of elaboration and restoration of forms and functions in accordance with developmental processes and the law of evolution. There is degeneration here, but it is not necessarily disease. Inflammation enters so largely as a factor in disease that it is worth our while to gather a few facts touching upon this question.

Two features characterize inflammation, viz.,

1. An active hyperemia.
2. An active tissue metamorphosis.

In active hyperemia the arteries, veins and capillaries become dilated, because the stimulus which causes them to contract has ceased to act or has become diminished, and the traumatic agency or influence has induced an impaired function of the special nerves of that part definitely known as the vaso-motor nerves.

That this impaired function of the nerves is a degeneration may be seen by recalling Spencer's well-known law of development, viz., "When a wave of molecular transformation passes through a nerve there is wrought in the structure of that nerve such a change that a like succeeding wave will pass through with greater facility than its predecessor."

The converse of this law must be equally true, viz., "When a wave of molecular transformation passes through a nerve with less facility than the preceding wave, there has been wrought in the structure of that nerve a change from a higher to a lower organization, and this is at least a temporary degeneration. Corroborative of this view are the recent developments of the so called "degeneration reaction" soon to be explained.

The cardinal symptoms of inflammation, redness and heat, not always being present, should be discarded as inaccurate, for when present both are fully explained by the active hyperemia, the redness by the increased quantity of red blood corpuscles and the heat by the accelerated blood current. That any of the heat is caused by degenerative tissue metamorphosis prior to the death of the tissue, *i. e.*, while the tissue is returning to the juvenile condition, is doubtful, for the temperature of the inflamed part is never higher than the temperature of the general blood circulation, and the elevation of temperature in inflammatory fevers is caused by the absorption of decomposing pus.

Pain, swelling and impaired function are explicable only on the hypothesis of tissue metamorphosis. Pain is accounted for by some tissues being more sensitive in the embryonic condition than in a mature state and also because of the swollen parts and the partial rupture or laceration of minute filaments of nerves. Pain and swelling, however, are not always present in inflammation. The swelling from infiltration and enlargement of the

cells is indicative of a more youthful condition of the tissues.

In the early beginnings of the embryo we see scarcely anything but cells separated by narrow traces of intermediate or basis substance. The older the tissue becomes the broader are the traces of intermediate or basis substance and the more slender are the cells and their processes. The reverse takes place in inflammation. The more advanced is the process of inflammation, the larger do the bodies of the cells and their processes become, and the smaller are the islands of basis substance which fill up the meshes of the network. This inflammatory infiltration and enlargement of the cells is preparatory to either the regeneration of the tissues, or it may be to their disintegration to pus.

This local disturbance, so retrogressive or degenerative in its character, and termed inflammation, has for its object not only the repair of the injury but the removal from the organism of those locally injurious influences that may have wrought or may persist in keeping up the inflammation. And without going into a detailed argument of a proposition so well known, it should be only necessary to state that all of the processes or changes of tissue that occur in inflammation are first degenerative; and when repair takes place they then become elaborated into their appropriate structure. The forms of degeneration which may accompany inflammation are various; they vary with the nature of the exciting cause and with the intensity of the inflammation, with the character and extent of the vascular disturbance and with the nature of the tissue. And when we take into consideration the great field of disease into which the inflammatory process enters as a factor, the value of the degeneration hypothesis is clearly seen.

With all due respect for the memory and the achievements of the great Cohnheim, it seems to me that his theory of the origin of neoplasms in "embryonic remains" must give place to one more true to nature. That nerve influence and local irritations do enter largely into the causes of neoplasms no one will be so rash as to deny. The epithelioma of scars, of the scrotum in sweeps and of the arm in paraffin workers and other instances forbid the idea of "embryonic remains." But they do show

that nature in response to known irritations or unknown influences proves herself true to the law that before one tissue can be transformed into another it must first return to the embryonal or juvenile condition, and the law of Virchow is proven true, that "the cellular elements of a tumor are derived from the pre-existing cells of the organism." There is no way of proving that these cells are "embryonic remains," but evidence is accumulating to show that the nerves known as the regulators of the nutritive functions and which connect the different parts of the same living organism with a common centre, have become impaired, as the experiments of Schroeder von der Kolk and others seem to verify.

The various forms of infiltration and degeneration, such as fatty, mucoid, colloid, calcareous, and pigmentary, are but the results of changed and imperfect nervous supply and a failure on their part to perform their normal action. This imperfect performance of nerve function is a diminished capacity for work and involves a change in the structure of the nerve, perhaps not discernible by any means at our command, but nevertheless still existing. These changes in function, and hence in structure, are retrogressive in character, and hence conform to our definition of degeneration as the third part of the law of evolution.

In many other diseases, particularly in the field of nervous and mental troubles, these ~~reversed~~ or degenerative changes reversed have been clearly traced. The axis cylinder of Purkinje and the white substance of Schwann become one homogeneous protoplasmic mass, the multiformity of the caudate cells with numerous processes changes to the uniformity of the round cells destitute of processes, while the medullary sheath soon blends also with this simple and uniform product. With this change of structure we observe a corresponding loss of function, and the complex movements seen in health become difficult or impossible. This is a change in the structure and function from the higher to the lower, from the complex to the simple, and is in conformity to the law of dissolution otherwise known as the law of degeneration. Not that all diseases clearly exhibit this law, for many are so rapid that the law cannot be traced, yet even in these glimpses of the law may be obtained. Parallel

with the changes in the nerves are analogous histological changes in the muscles, glands, organs or parts supplied by them.

Experimental and clinical investigations have proven that these degenerative changes are characterized in the main by diminution and loss of the faradic and galvanic irritability of the nerves, and the faradic irritability of the muscles, and this loss of power demonstrated by electricity is characterized as "degeneration reaction." It follows, therefore, that wherever degeneration reaction is found to exist, there is degeneration, and its extent and quality may be largely determined by the degree of disturbance in the electrical conduction. A slight depression of faradic and galvanic irritability occurs in the nerves in comparatively mild diseases and disappears with relative rapidity. In these cases it is probable that the nerve is very slightly or only temporarily degenerated.

Many other illustrations of the truth of this law of dissolution or, as others have called it, the law of degeneration, could be presented did time permit. That it is the great law that regulates the phenomena of all diseases we have abundant reason to believe. Whether it should be termed the law of degeneration, as I believe, or the law of dissolution, or the law of retrograde metamorphosis, may be a question to be decided. But whatever terms are used the facts remain incontrovertible. There are many unanswered questions in pathology and physiological therapeutics that I believe a better knowledge of this law will help us to solve.

What means the natural period of the duration of some diseases?

May it not be the time necessary for the parts affected to revert to their embryonic type and for resolution to begin? Perhaps it will prove to be in pathology what Ohm's law is in electricity. We can wander as far as we will into the fields of electricity and we need never get lost so long as we keep definitely in mind this guiding principle. So with the law of degeneration as the guiding star in the study of disease, we launch out to explore the unknown fields of pathology, retracing every step in accordance with the truths taught in embryology.

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